# APPENDIX 1

The MMU detects the presence of voltage on conflicting field connection terminals, the absence of proper voltages on all of the signal field connection terminals of a channel, and monitors for the presence of satisfactory operating voltages within the Controller Unit (CU) and the MMU itself. If any of these conditions exist or are out of tolerance for the minimum time defined in Section 4 of the NEMA Standards Publication TS 2-1998, the Output relay's normally open contacts will transfer from the no fault state (relay energized) to the fault state (relay de-energized). The closure of the Output relay contacts will cause the transfer of the traffic signals to Flashing Operation. The fault is recorded by the MMU-1600 and displayed on the appropriate LED indicators.

The MMU will operate in one of two modes depending on the signal level on the Type Select input. If the Type Select input is at Logic Ground potential, the MMU will operate as a Type 16 with sixteen channels, otherwise it will operate as a Type 12 with twelve channels. A front panel switch is also available to override the Type Select input and force the MMU-1600 into the Type 16 mode.

Type 16 – Each of sixteen channels consists three 120 volt AC outputs: Green/Walk, Yellow, and Red/Don't Walk.

Type 12 – Each of twelve channels consists four 120 volt AC outputs: Green, Yellow, Walk, and Red.

For TS 2 type operation the MMU is usually configured as a Type 16. The Type 16 MMU is intended for those applications in which there are three circuits per channel and the MMU channels have been wired in a one-to-one correspondence with the load switches, as defined in Section 5.5.3, Paragraph 9 of the NEMA Standards Publication TS 2-1998. The Type 12 MMU is intended to provide downward compatibility with a 12 channel conflict monitor unit (CMU) conforming to TS 1-1989.

The signal monitor portion of the MMU is capable of monitoring for the presence of voltage on conflicting field connection terminals in the Controller Assembly. For the purpose of conflict determination, a signal on any of the Green, Yellow, or Walk inputs associated with a channel shall be considered as that channel being active.

The signal monitor portion of the MMU is also capable of monitoring for the absence of any required signal voltage on each channel at the field connection terminals in the Controller Assembly. For this purpose a signal on the Green, Yellow, Walk, or Red/Don't Walk inputs associated with a channel shall be considered as that channel being active.

The voltage monitor portion of the MMU is capable of monitoring the Controller Unit Voltage Monitor output that indicates satisfactory operating voltage in the Controller Unit and the +24 volt direct current inputs.

The MMU is fully programmable. An interchangeable Program Card is provided to allow the assignment of permissive or compatible channels. Programming is accomplished through the use of soldered wire jumpers on the Program Card. The Program Card may be used in an MMU operating in either Type 16 or Type 12 mode. The Program Card can be inserted into the MMU through a slot in the front panel. The Program Card also contains a serial EEPROM. This device is used to store programming information not set by the wire jumpers. Currently, Flashing Don't Walk Monitoring is the only feature to store settings in the serial EEPROM.

When configured in the Type 16 mode and connected to a TS 2 Controller Unit, the MMU unit has the ability to exchange information in a standardized format with the Controller Unit in real time through the Port 1 interface. The MMU and the Controller Unit perform

redundant checks on each other through messages defined in the TS 2 Standard. The Controller Unit can access all MMU unit information including field signal input status, permissive programming, and fault status. This gives the Controller Unit the capability to function as a backup monitor and make enhanced event logging, remote intersection monitoring, and remote diagnostics possible. Likewise, the MMU unit receives information from the Controller Unit corresponding to Controller Unit output commands to the various load switches. Access to this information allows the MMU unit to more accurately respond to and diagnose fault situations.

Requirements outlined in the TS 2 Standard provide for messages to be generated by the Controller Unit and the MMU unit, which effectively extend the communications capabilities of a standard assembly. The MMU utilizes these message facilities to provide the highest level of enhanced application specific diagnostic reporting and monitoring.

### 1.1.1 INPUTS

#### 1.1.1.1 AC Line

The over-current protected side of 120 volt AC 60 hertz source. This input (Connector A – Pin "A") is used to generate the voltages required to operate the monitoring logic.

The MMU has a front panel mounted over-current protection device in the 120 volt AC input to the unit. This fuse is a 1/4 AMP SLO-BLOW and should only be replaced with a fuse of the same type and value.

#### 1.1.1.2 AC Neutral

The unfused and unswitched return side of 120 volt AC 60 hertz power source is taken from the neutral output of the AC power source. This input (Connector A – Pin "V") is the referenced signal for all field terminal voltage sensing inputs. This input is not connected to Logic Ground or Earth Ground within the unit.

#### 1.1.1.3 Earth Ground

The MMU has an input terminal (Connector A – Pin "U") providing an independent connection to the chassis of the unit. This input is not connected to Logic Ground or AC Neutral within the unit.

#### 1.1.1.4 Logic Ground

A voltage reference point and current return for the Reset input, Controller Voltage Monitor input, +24V Monitor I input, +24V Monitor II input, Type Select input, +24V Monitor Inhibit input, Local Flash Status input, and Port 1 Disable input logic circuits. This termination (Connector A – Pin "T") is not connected to either the AC Neutral or Earth Ground within the unit.

#### 1.1.1.5 +24V Monitor DC Inputs

Two +24 volt DC inputs, +24V Monitor I (Connector A – Pin "S") and +24V Monitor II (Connector B – Pin "R"), are monitored to assure proper +24 volt DC levels. Actual DC Voltages are measured and monitored 1000 times per second to ensure proper values. The two 24 VDC Monitor Inputs can be accessed in real-time via the serial port. The actual voltages are also recorded in the Signal Sequence Log if a fault occurs.

### 1.1.1.6 Control Inputs

The Reset input (Connector A – Pin "BB"), Controller Voltage Monitor input (Connector A – Pin "V"), Type Select input (Connector A – Pin "HH"), +24V Monitor Inhibit input (Connector A – Pin "n"), Local Flash Status input (Connector B – Pin "c"), and Port 1 Disable input (Port 1 SDLC Connector – Pin 10) are logic level inputs and conform to requirements outlined in Section 3.3.5.1.1 of NEMA Standards Publication TS 2-1998. These signals are all low state (nominal 0 volts) for the true state. When not activated, the inputs are internally biased to the false (high) non-operate state (+24 volt DC).

Actual DC Voltages are measured and monitored 1000 times per second to ensure proper values. The actual DC voltage levels of the CVM, External Reset Input, Type Select Input, 24V Monitor Inhibit and External Watchdog can be accessed in real-time via the serial port. The actual voltages are also recorded in the Signal Sequence Log if a fault occurs.

### 1.1.1.7 Cabinet Interlock

The MMU has two terminals internally connected to indicate the presence of the unit to the external circuitry. These terminals are identified as Cabinet Interlock A (Connector A – Pin "CC") and Cabinet Interlock B (Connector A – Pin "DD").

### 1.1.1.8 Field Terminals

Each field terminal input is measured 720 times per second to provide an accurate, true RMS AC voltage regardless of distortions in the waveform. The RMS voltage is calculated every 33 milliseconds for every AC input. Voltages can be accessed in real-time via the serial port and are recorded in the Signal Sequence Log if a fault occurs.

**Type 16** – Three inputs are provided for each channel to permit the monitoring of voltages at the Green/Walk, Yellow, and Red/Don't Walk signal field terminals. The unit is designed so that it is not necessary to terminate unused Green, Yellow, or Walk signal sensing inputs when the impedance to the AC Line of each of these inputs is less than the equivalent of 1500 picofarads (pF) between the input and AC Line as measured at the input of the unit.

**Type 12** – Four inputs are provided for each channel to permit the monitoring of voltages at the Green, Yellow, Red, and Walk signal field terminals. The unit is designed so that it is not necessary to terminate unused Green, Yellow, or Walk signal sensing inputs when the impedance to the AC Line of each of these inputs is less than the equivalent of 1500 picofarads (pF) between the input and AC Line as measured at the input of the unit.

A Green, Yellow, or Walk signal input is sensed when it exceeds 25 volts RMS AC and a signal input is not sensed when it is less than 15 volts RMS AC. Signals between 15 and 25 volts RMS AC may or may not be sensed. Both positive and negative half wave rectified signals are sensed. The RMS measurement is made over a minimum period of at least two cycles.

A Red/Don't Walk signal input requires the presence of 60 ± 10 volts RMS AC at the field terminal to satisfy the requirements of a Red/Don't Walk signal indication. Both positive and negative half wave rectified signals are sensed. The RMS measurement is made over a minimum period of at least two cycles.

When the circuit connected to the sensing input of the unit exhibits high impedance characteristics such as those caused by dimmers or burned out

lamps, it may be necessary to place a low impedance device external to the unit between the unit input and AC Neutral. See Section 6.2.4 of NEMA Standards Publication TS 2-1998.

#### 1.1.1.9 R d Enabl

The presence of the proper voltage at this terminal (Connector B – Pin "a") enables the MMU to detect the absence of voltage on all field signal inputs of a channel. The absence of the proper voltage inhibits the detection of the absence of voltage on all field signal inputs of a channel. This input is considered enabled when the input voltage exceeds 89 volts RMS AC at the Red Enable input. This function is considered not enabled when the input voltage is less than 70 volts RMS AC at the Red Enable input.

The presence of the proper voltage at this terminal also enables Minimum Yellow Change/Red Clearance Interval Monitoring. The absence of the proper voltage at this terminal inhibits Minimum Yellow Change/Red Clearance Interval Monitoring.

The MMU will not recognize state changes of the Red Enable input while AC power is not valid. This ensures that short power interruptions do not cause unintended state changes of the Red Enable input.

#### 1.1.1.10 Type Select Input

The MMU operates as a Type 16 with sixteen channels when the Type Select input (Connector A – Pin "HH") is at logic True (Low) state; otherwise it operates as a Type 12 with twelve channels.

**Type 16** - When configured for Type 16 mode of operation, each channel has the capability of monitoring a Green (Walk), a Yellow, and a Red (Don't Walk) field signal output at the Terminals and Facilities field terminals. Type 16 is intended for those applications in which there are three circuits per channel and the MMU channels have been wired in a one-to-one correspondence with the load switches, as defined in Section 5.5.3, Paragraph 9 of the NEMA Traffic Controller Assemblies Standards Publication TS 2-1998. The 16 front panel channel LEDs labeled "G" indicate status of the Greens & Walks, LEDs labeled "Y" indicate status of the Yellows, and LEDs labeled "R" indicate status of the Reds & Don't Walks. The LEDs labeled "W" are not used in the Type 16 mode of operation.

**Type 12** - When configured for Type 12 operation, each channel has the capability of monitoring a Green, a Walk, a Yellow, and a Red field signal output at the Terminals and Facilities field terminals. Type 12 is intended for those applications in which downward compatibility with 12 channel Conflict Monitor Units (CMU) conforming to NEMA Traffic Control Systems Publication TS 1-1989 is required. The 12 front panel channel LEDs labeled "G" indicate status of the Greens, LEDs labeled "Y" indicate status of the Yellows, LEDs labeled "W" indicate status of the Walks, and LEDs labeled "R" indicate status of the Reds. The channel LEDs numbered 13 through 16 are not used in the Type 12 mode of operation.

All Port 1 communications activity is disabled when the MMU is configured to operate as a Type 12.

#### 1.1.1.11 Local Flash Status

The MMU transfers the Output Relay contacts to the Conflict state and sets the Local Flash Status bit (bit 79) in the Type 129 Frame to 1 when this input

(Connector B – Pin "c") is TRUE. At all other times, the Local Flash Status bit of the Type 129 Frame is set to 0.

### 1.1.2 OUTPUTS

#### 1.1.2.1 Output Relay

The Output relay of the MMU has two sets of isolated Form C contacts. These relay contacts are capable of switching all loads in the range from 2 milliamps at 18 volts DC to 3 amperes at 135 volts RMS AC.

The open circuits of the Output relay are the circuits that are open when the unit is in the No Fault state and all voltages are sufficient for proper operation of the Controller Assembly. The relay coil is energized in the No Fault state.

Prior to the MMU transferring the Output relay contacts from the Fault state to the No Fault state, a Transition state with a duration of 500 milliseconds occurs. During the Transition state the Output relay contacts are the same as the Fault state and the MMU sets the Start-Up Flash Call bit (bit 80) of the Type 129 Frame to 1. At all other times the Start-Up Flash Call bit of the Type 129 Frame is set to 0.

#### 1.1.2.2 Start-Delay Control

The MMU includes a means of detecting an MMU Power Failure. Upon restoration of AC Line following an MMU Power Failure, the Start-Delay relay maintains continuity between its common and open contacts for a period of 2.0 ±0.5 seconds. Following this 2.0 second time period, the Start-Delay relay enables continuity to occur between its common and closed contacts.

The Start-Delay relay has one set of Form C relay output contacts. These relay contacts are capable of switching all loads in the range from 2 milliamps at 18 volts DC to 3 amperes at 135 volts RMS AC.

The operation of the Start-Delay relay normally results in the initiation a start-up sequence within the Control Unit by interrupting the AC Line input to the Control Unit.

#### 1.1.2.3 Display

The MMU provides the following indications:

1. Triggering of the +24 Voltage Monitor I monitoring portion of the unit.
2. Triggering of the +24 Voltage Monitor II monitoring portion of the unit.
3. Triggering of the Controller Voltage Monitor or External Watchdog monitoring portion of the unit.
4. Triggering of the Conflict monitoring portion of the unit.
5. Triggering of the Internal Diagnostics monitoring portion of the unit.
6. Triggering of the Minimum Yellow Change monitoring portion of the unit.
7. Triggering of the Minimum Yellow Plus Red Clearance monitoring portion of the unit.
8. Timeout failure on Port 1.
9. Triggering of the Field Check monitoring portion of the unit.
10. Local Flash Status input is TRUE.
11. Triggering of the Red monitoring portion of the unit.
12. Triggering of the Dual Indication monitoring portion of the unit.
13. Program Card not inserted into the unit.

The indication specified in 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, and 13 are not reset by an MMU Power Failure and retain their latched state until the unit is reset by the activation of the front panel control or the activation of the Reset input. If a voltage monitor fault is non-latching, the indicator specified in 1, 2, or 3 will indicate the current state of the input being monitored.

### 1.1.3 PROGRAMMING CARD

The MMU is fully programmable and requires programming action to provide configuration information. Programming is accomplished through the use of soldered wire jumpers on an interchangeable Programming Card.

The Programming Card plugs into the MMU through a slot in the front panel. The MMU is constructed with card guides to ease the insertion of the Programming Card. The Programming Card includes card ejectors to ease removal of the Programming Card. The edge of the Programming Card is flush with the surface of the front panel when it is properly seated in the program card slot of the MMU. The PRGM CARD LED will illuminate if the Programming Card is not properly seated while power is applied.

Programming Cards have an integral serial EEPROM which can store settings for one or more of several Extended NEMA features. If this device is activated through the software and is not functioning properly, a diagnostic failure will occur and the PRGM CARD LED will begin to flash at a 5 Hz rate. If an unauthorized Programming Card is inserted in the program card slot and the "Use Program Card EEPROM" feature is activated, the PRGM CARD LED will flash at a 5 Hz rate.

See Table 3.5 for pin assignments for the connector on the Programming Card.

#### 1.1.3.1 Minimum Flash

The Programming Card has four pairs of 1.09 mm (0.043 in) diameter holes for programming jumpers. One hole of each pair is connected to the common pin (pin #32) on rows A, B, and C on each connector. The four jumper hole pairs are logically labeled for easy identification of the jumper holes in binary weighted fashion. A soldered wire jumper in a jumper hole pair adds that designated input value to the binary weighted sum plus one.

#### 1.1.3.2 Minimum Yellow Change Channel Disable

The Programming Card has sixteen pairs of 1.09 mm (0.043 in) diameter holes for programming jumpers. One hole of each pair is connected to the common pin (pin #32) on rows A, B, and C on each connector. The sixteen jumper hole pairs are logically labeled for easy identification of the channel numbers. A soldered wire jumper in a jumper hole pair disables Minimum Yellow Clearance monitoring for that channel.

#### 1.1.3.3 Voltage Monitor Latch

The Programming Card has two pairs of 1.09 mm (0.043 in) diameter holes for programming jumpers. One hole of each pair is connected to the common pin (pin #32) on rows A, B, and C on each connector. The two jumper hole pairs are logically labeled for easy identification of the +24 Volt Latch input and CVM Latch input. A soldered wire jumper in a jumper hole pair causes these fault conditions to be latched.

#### 1.1.3.4 Chann I Compatibility

The MMU is fully programmable and requires programming action to provide compatibility between channels.

Programming is accomplished through the use of soldered wire jumpers on an interchangeable Programming Card. The interchangeable Programming Card may be used with an MMU operating in either Type 16 or Type 12 mode.

The Programming Card plugs into the MMU through a slot in the front panel. The MMU is constructed with card guides to ease the insertion of the Programming Card. The Programming Card includes card ejectors to ease removal of the Programming Card.

The edge of the Programming Card is flush with the surface of the front panel when it is properly seated in the program card slot of the MMU. The PRGM CARD LED will illuminate if the Programming Card is not properly seated while power is applied.

The Programming Card has 120 pairs of 1.09 mm (0.043 in) diameter holes for programming jumpers. One hole of each pair is connected to the common pin (pin #32) on rows A, B, and C on each connector. The 120 jumper hole pairs are logically labeled for easy identification of the jumper holes by channel pairs. A soldered wire jumper in a jumper hole pair defines a pair of channels as permissive or compatible.

#### 1.1.3.5 Serial EEPROM

The Programming Card contains a serial EEPROM. This device is not called for in the NEMA TS-2 specification and is only compatible with the MMU described herein. The Program Card is interchangeable with other manufacturer's Program Cards for the programming of the standard features. The serial EEPROM is provided as a way of storing programming settings for some of the Extended NEMA features of this MMU.

Using an unauthorized Programming Card in this MMU will result in the MMU not being able to store or retrieve programming settings for some of the Extended NEMA features. Specifically, the Flashing Don't Walk Monitoring per channel enables, the Per Channel Red enables, and Co-Channel Child assignments. If these features are not being used, any Programming Card will provide full functionality.

### 1.1.4 FUNCTIONS

#### 1.1.4.1 MMU Power Failure

The MMU responds to a Power Failure by entering a non-latching flash state. The MMU responds to a Power Failure whether it is the result of over-current protection device operation, failure of the MMU power supply, or absence of proper operating AC Line voltage as defined below.

The operating AC Line input is considered to be On if the voltage level is greater than 98 volts RMS AC and it is considered to be Off if the voltage level is less than 89 volts RMS AC. The hysteresis from the Off state to the On state or vice versa is at least 3 volts RMS AC.

The MMU responds to Power Failure as follows:

1. If the AC Line input is Off for 450 milliseconds or less, the MMU continues to operate as though the AC Line had remained On. The Output relay contacts

do not transfer to the fault condition during this interval. The Start-Delay relay maintains continuity between its common and closed contacts.

2. If the AC Line input is Off for 500 milliseconds or more, the MMU transfers the Output relay contacts to the fault condition. The Start-Delay relay enables continuity between its common and open contacts. The time interval from the start of the AC Line input being Off and the transfer of both relays to these states does not exceed 525 milliseconds. Both relays maintain these states for the duration of the Power Failure.

#### 1.1.4.2 Minimum Flashing Indication

The MMU includes a means of detecting an MMU Power Failure. The detection of an MMU Power Failure transfers the Output relay contacts to the fault condition. The state of the Output relay contacts is maintained for a timed interval following the restoration of power to the AC Line input. This timed interval is the Minimum Flash time. The duration of the Minimum Flash time is adjustable between the limits of 6 seconds and 16 seconds with an incremental adjustment of one second.

All MMU initiated flash conditions will last for the programmed Minimum Flash time unless terminated by use of the front panel reset switch or Reset input command.

#### 1.1.4.3 Conflict Monitoring

When voltages on any conflicting channels are detected as concurrently active for 450 milliseconds or more, the MMU transfers the Output relay contacts to the fault condition, illuminates the CONFLICT indicator on the front panel, and sets the Conflict bit (bit 65) of the Type 129 Frame to 1. The time interval between the beginning of the concurrently conflicting channels and the transfer of the Output relay contacts to the fault condition does not exceed 450 milliseconds.

When the MMU transfers the Output relay contacts to the fault condition, it enables continuity between the open and common contacts of the Output relay. These contacts remain in this fault condition until the unit is reset by the activation of the front panel reset switch or the activation of the Reset input.

An MMU Power Failure does not reset the MMU when it has been triggered by a conflict prior to the MMU Power Failure.

#### 1.1.4.4 Red Monitoring

The MMU is capable of monitoring for the absence of voltage on all of the inputs to a channel. When an absence of all signal voltage to a channel is detected for 1000 milliseconds or more, the MMU transfers the Output relay contacts to the fault condition, illuminates the RED FAIL indicator on the front panel, and sets the Red Failure bit (bit 66) of the Type 129 Frame to 1. The time interval between the beginning of the absence of signal voltage on a channel and the transfer of the Output relay contacts to the fault condition does not exceed 1000 milliseconds.

Red monitoring is disabled when the Red Enable input is not active or if the Load Switch Flash bit (bit 112) of the Type 0 Frame is set to 1. Red monitoring can be enabled on a per channel basis when the Per Channel Red Enable feature is active. See below for more information on this feature.

When the MMU transfers the Output relay contacts to the fault condition it enables continuity between the open and the common contacts of the Output relay. These contacts remain in this fault condition until the unit is reset by the activation of the front panel reset switch or the activation of the Reset input.

An MMU Power Failure does not reset the MMU when it has been triggered by detection of absence of signal voltage on a channel prior to the MMU Power Failure.

### 1.1.4.5 Minimum Yellow Change / Red Clearance Interval Monitoring

#### 1.1.4.5.1 Yellow Plus Red Interval

The MMU verifies that the Yellow Change Plus Red Clearance interval between the end of an active Green signal and the beginning of the next conflicting Green signal is at least 2.7 ± 0.1 seconds. When the minimum Yellow Change Plus Red Clearance interval is not satisfied, the MMU transfers the Output relay contacts to the fault condition, illuminates the SHORT CLR indicator on the front panel, and sets the Minimum Clearance Failure bit (bit 74) and Spare Bit #5 (bit 71) of the Type 129 Frame to 1.

#### 1.1.4.5.2 Yellow Change Interval

The MMU verifies that the Yellow Change interval signal is at least 2.7 ± 0.1 seconds. When the minimum Yellow Change interval is not satisfied, the MMU transfers the Output relay contacts to the fault condition, illuminates the SHORT YEL indicator on the front panel, and sets the Minimum Clearance Failure bit (bit 74) of the Type 129 Frame to 1.

Minimum Yellow Change / Red Clearance monitoring is disabled when the Red Enable input is not active or if the Load Switch Flash bit (bit 112) of the Type 0 Frame is set to 1. This test can also be disabled on a per channel basis using the MYCD jumpers on the program card.

When the MMU transfers the Output relay contacts to the fault condition it causes continuity between the open and the common contacts of the Output relay. These contacts remain in this fault condition until the unit is reset by the activation of the front panel reset switch or the activation of the Reset input.

An MMU Power Failure does not reset the MMU when it has been triggered by a detection of a fault prior to the MMU Power Failure.

### 1.1.4.6 Port 1 Timeout

If a Type 0 Frame has not been received from the CU for 300 milliseconds, the MMU will transfer the Output relay contacts to the Fault state and the PORT 1 FAIL indicator will illuminate. When receipt of a Type 0 Frame occurs again, the MMU will transfer the Output relay contacts to the No Fault state unless three Port 1 timeouts have occurred in a calendar day. The MMU will not exit this third timeout state without user interaction (activation of the front panel reset switch or activation of the Reset input) or AC power being removed and reapplied. A user interaction will reset Port 1 Timeout counts to zero. AC power interruptions will not reset this count and the next Port 1 Timeout in the same calendar day or 24 hour period shall enter the Third Timeout state.

A Port 1 Timeout failure during the programmed Minimum Flash time or during an MMU Power Failure shall not cause a latched fault condition. The Port 1

Timeout function is disabled if the Port 1 Disable input is at a True (Low) state or the MMU is selected to operate as a Type 12.

### 1.1.4.7 Voltag Monitoring

The MMU includes the capability of monitoring two +24 volt DC sources applied to its +24 Volt Monitor inputs. Absence of the proper voltage level at either of these inputs causes the unit to transfer the Output relay contacts to the fault condition. Restoration of all proper voltage levels resets the Voltage Monitoring portion of the MMU. A +24 volt DC failure during the programmed Minimum Flash time or during an MMU Power Failure does not cause a fault condition.

A method of programming is provided on the programming card to cause the +24 volt DC failures to latch in the fault condition until the unit is reset by the activation of the front panel reset switch or activation of the Reset input. A latched +24 volt DC failure is not reset by an MMU Power Failure.

#### 1.1.4.7.1 +24 Volt Monitor

A voltage greater than +22 volts DC applied to both of the +24 Volt Monitor inputs is recognized by the MMU as adequate for proper operation of the CA. A voltage of less than +18 volts DC applied to either of the +24 Volt Monitor inputs is recognized by the MMU as inadequate for proper operation of the CA.

When a +24 Volt Monitor input is detected as inadequate for more than 175 milliseconds, the MMU transfers the Output relay contacts to the fault condition, illuminates the 24V-1 and/or 24V-2 indicator on the front panel, and sets the appropriate +24 Volt Monitor I bit (bit 58) and/or +24 Volt Monitor II bit (bit 59), of the Type 129 Frame to 1. The time interval between the beginning of the inadequate voltage level and the transfer of the Output relay contacts to the fault condition does not exceed 450 milliseconds.

#### 1.1.4.7.2 +24 Volt Monitor Inhibit Input

Application of a True (Low) state to this input inhibits the operation of the +24 Volt Monitor and sets the +24 Volt Monitor Inhibit bit (bit 60) of the Type 129 Frame to 1.

### 1.1.4.8 Controller Voltage/Fault Monitor Input

The MMU includes a Controller Voltage Monitor (CVM) input. When a True (Low) input is absent for more than 175 milliseconds, the MMU transfers the Output relay contacts to the fault condition, illuminates the CVM/WD indicator on the front panel, and sets the Controller Voltage Monitor bit (bit 57) of the Type 129 Frame to 1. The time interval between the beginning of the absence of a True (Low) input and the transfer of the Output relay contacts to the fault condition does not exceed 450 milliseconds. A Controller Voltage Monitor failure during the programmed Minimum Flash time or during an MMU Power Failure does not cause a fault condition.

A programming means is provided on the programming card to cause the CVM failures to latch in the fault condition until the unit is reset by the activation of the front panel reset switch or activation of the Reset input. A latched +24 volt DC failure is not reset by an MMU Power Failure.

#### 1.1.4.9 R s t

Activation of the front panel manual reset switch or the Reset input causes the two Form C Output relay contacts to transfer to the no fault condition. The MMU remains in the no fault condition only if there are no existing faults and all input voltages are at the proper operating levels.

Each activation of the front panel manual reset switch or the Reset input causes a one-time reset input to the MMU. A continuously activated front panel reset or Reset input will not prevent the MMU from monitoring any fault conditions and/or transferring the Output relay contacts to the fault condition. The front panel reset or Reset input must be removed and reapplied to activate a new reset input to the MMU.

The only intended purpose of the Reset input is to facilitate bench testing of the MMU.

### 1.1.5 DIAGNOSTICS

The MMU is provided with a series of resident self-check diagnostics capabilities. When a fault is detected, the MMU transfers the Output relay contacts to the fault condition and illuminates the front panel DIAG LED. Diagnostic failures are latched in the fault condition until the unit is reset by the activation of the front panel reset switch or activation of the Reset input. A diagnostic failure is not reset by an MMU Power Failure.

Failure of any of these diagnostics will result in the MMU Diagnostic Failure bit (bit 73) of the Type 129 Frame being set to 1. NOTE: Port 1 communications may not be possible during certain diagnostic failures.

#### 1.1.5.1 Memory

The MMU verifies all memory elements on power up or upon reset of a Diagnostics failure. A failure of any of the memory tests will generate a diagnostics failure.

RAM Diagnostics – Test patterns are written to every byte of RAM in the MMU. After each write a read is performed to verify that the pattern is correct.

Flash ROM Diagnostics – A checksum is calculated for all of the ROM in the MMU. The calculated value is compared to a preprogrammed value stored in the ROM.

EEPROM Diagnostics – A checksum is calculated for all of the internal EEPROM in the MMU. The calculated value is compared to a preprogrammed value stored in the internal EEPROM.

Program Card EEPROM Diagnostics – A checksum is calculated for all of the EEPROM on the Program Card. The calculated value is compared to a preprogrammed value stored in the Program Card EEPROM.

The MMU continues to verify the Flash ROM, internal EEPROM, Program Card EEPROM during normal operation. Checksums are calculated for the Flash ROM and internal EEPROM at a rate of at least 1024 bytes per second. Checksums are calculated for the entire Program Card EEPROM once per second.

### 1.1.5.2 Microproc ss r Monitor

The MMU monitors the operation of its microprocessor. The monitoring circuit receives a signal or logic state transition at least once every 50 milliseconds from the microprocessor. When the signal or logic state transition is not received for more than 200 milliseconds a diagnostics fault is generated.

The microprocessor will stop generating logic state transitions when any of the following are detected:

PROM Checksum Mismatch.
EEPROM Checksum Mismatch.
EEPROM Write Error.
RAM Read/Write Error.
RMS Data Transfer Error.
RMS Calculation Error.
Communications Timeout to DC Processor.
Communications Timeout to Watchdog Processor.
Communications Timeout to Temperature Sensor.
All Scheduled Foreground and Background Tasks did not Complete in the Allotted Time.
Program Card EEPROM Checksum Mismatch.
Program Card Data Transfer Error.
Program Card Jumpers could not be Read Reliably.

### 1.1.5.3 Internal Voltage Monitors

The MMU monitors the voltage levels of the internal DC power supplies. The 35 volt, 5 volt, 3.3 volt, and 2.5 volt power supplies are all monitored for proper voltage levels. When any of these voltage levels is invalid for more than 125 milliseconds a diagnostics fault is generated. These faults will not be logged by the MMU, as any one of these voltages being invalid will immediately place the MMU in a diagnostic failure mode with the microprocessor held in reset. This prevents any false faults or missed faults due to an internal power supply malfunction.

If the MMU is experiencing an internal power supply malfunction, the DIAG LED on the front panel will flash a diagnostic code to identify which voltage is out of tolerance. To read the diagnostic code, wait for a long on period of the DIAG LED. Then count the number of flashes that follow. If there is a second digit in the diagnostic code, a short on period will be followed by another set of flashes. The following table summarizes the possible diagnostic codes:

| DIAGNOSTIC CODE | CAUSE |
|---|---|
| 2 flashes followed by 5 flashes | 2.5 volt supply |
| 3 flashes followed by 3 flashes | 3.3 volt supply |
| 3 flashes followed by 5 flashes | 35 volt supply |
| 5 flashes | 5 volt supply |

**NOTE**: Adjustments or repairs to any of these supplies should only be performed at the Reno A & E production facility, as the MMU will require factory recalibration afterwards.

## 1.2 EXTENDED NEMA TS 2-1998 FEATURES

The MMU includes several features that are designed to enhance the safety and operation of the MMU. These features extend the MMU features beyond the requirements of the NEMA Standards Publication TS 2-1998.

### 1.2.1 HARDWARE FEATURES

The MMU unit incorporates a 16-bit microprocessor as the main processing unit and 9 microcontrollers. All 9 microcontrollers are flash based and can be reprogrammed in circuit. The main processor uses two program memory chips. These chips can be PROM, EPROM, or Flash. These two chips are socketed to facilitate easy upgrades to the unit.

One of the nine microcontrollers is dedicated to monitoring internal voltages and diagnostic signals from the other microcontrollers and the main microprocessor. This microcontroller holds the rest of the system in the reset state until the AC Line voltage and all supply voltages have been verified as being within operational ranges.

The MMU is entirely connectorized internally. The two wires to the front panel fuse are the only exception. This makes the MMU very easy to assemble, disassemble, and maintain. The possibility of wiring errors within the unit has been eliminated.

The MMU has an internal buzzer that stays on to indicate when the main processor is not running. This will only occur very briefly during power up, 1.5 seconds after loss of AC power, and during major diagnostic failures.

All of the AC inputs to the MMU are factory calibrated to ±2% of actual RMS voltage.

### 1.2.2 REAL TIME CLOCK

The MMU-1600 has a Real Time Clock (RTC) feature that is used as a reference for all date and time stamped documentation pertaining to events that are logged by the MMU. The Real Time Clock is initialized to local *Pacific Standard Time* when the unit is undergoing final test. In addition, the Daylight Saving Time user option is set to Off.

The Real Time Clock is preprogrammed to recognize Leap Years and Daylight Saving Time events through the year 2099. Currently, per U.S. Federal standards, Daylight Saving Time is observed in the United States from 2:00 A.M. on the first Sunday in April until 2:00 A.M. on the last Sunday in October.

The update priority of any time setting that affects the Real Time Clock is as follows:

1. Controller Time - The Real Time Clock is programmed with the time setting stored in the Controller. This information is input into the Real Time Clock via the PORT 1 SDLC connector on the front of the MMU. If the Real Time Clock setting differs from the Controller Time setting by more than two (2) seconds, The Real Time Clock will be synchronized to the Controller clock. In the event that the Real Time Clock setting differs from the Controller Time setting by five (5) or more seconds, the Real Time Clock will be synchronized to the Controller clock and an entry will be made to the Time Change Log.
2. External Time Source (i.e. Laptop Computer) - The Real Time Clock setting can be modified through the use of the software supplied with the MMU. This information is input into the Real Time Clock via the COMM PORT serial connector on the front of the MMU. NOTE: Whenever the MMU is connected to

an operational SDLC bus, any time setting entered via the serial port will be overwritten by the Controller Time setting.

3. Internal Time (i.e. MMU Real Time Clock Setting) - If there is (are) no connection(s) made to the MMU via the PORT 1 SDLC connector or the COMM PORT connector, the internal time setting stored in the Real Time Clock is used.

If it is necessary to change the Real Time Clock setting in an MMU that is being used in a NEMA TS 2 Cabinet Assembly, change the time setting on the cabinet controller. The time change will be broadcast to the MMU through the SDLC port.

### 1.2.3 UP TIME ACCUMULATOR

The MMU has an Up Time Accumulator that keeps track of the total amount of time that the MMU has been powered up since it was manufactured. It is saved in the format of Years, Months, Days, Hours, Minutes, and Seconds. Tracking and recording the total time that the unit was in service provides an accurate means of validating any potential warranty claims.

### 1.2.4 SETTABLE CONFIGURATION DATA

The MMU has an EEPROM that is used to store factory and user configuration data. This EEPROM is verified with a checksum on power up to validate its contents to insure that unintended configurations are not used. The EEPROM has storage for factory settings, user settings, and all logs. A software program allows the user to easily view and save any factory settings and to view, modify, and save any user configurable settings.

#### 1.2.4.1 Factory Settings

The MMU is configured at the factory during final test. Data set at the factory includes: Model Number, Serial Number, Manufacture Date, Real Time Clock setting, Support for Flashing Greens, Enhanced Support of Econolite Controllers, Support for a Diagnostic LCD. The Up Time Accumulator is initialized to zero prior to final testing. Changes to Support for Flashing Greens, Enhanced Support of Econolite Controllers, and Support for a Diagnostic LCD are logged in the configuration log.

#### 1.2.4.2 User Settings

Through the software program, the user can view all of the factory settings and set the following parameters: Agency ID, Location, Unit ID, Com Port Settings, Signal Sequence Logging Mode, Log Local Flash events, Log CVM events, Co-Channel Childs include Yellows, Disabling of the Buzzer for Configuration Changes, Daylight Saving Time, Flashing DW Monitoring channels, Per Channel Red Enable channels, and Co-Channel Child settings. Changes to any of these settings are logged in the configuration log.

### 1.2.5 CONFIGURATION MONITORING

The MMU unit checks all configuration settings for changes every one second. If a change is found, an audible buzzer will start beeping to indicate that a configuration setting has changed. If the change is undone, the beeping will stop. No configuration changes are implemented until the front panel RESET switch or external RESET input is activated. At that time the new settings will be implemented and a Configuration Change log entry made. The following configuration settings are monitored: Programming Card jumpers, Programming Card EEPROM stored settings, Front Panel DIP switches, Type Select input,

Factory Options set through the software, and User Options set through the software.

### 1.2.6 DUAL INDICATION MONITORING

This monitoring feature functions in the manner its name implies. It monitors for simultaneously active inputs of Green (Walk), Yellow, or Red (Don't Walk) on the same channel. A set of switches on the front panel labeled FIELD CHECK / DUAL ENABLES is provided to allow Dual Indication monitoring to be enabled on a per channel basis.

**Type 12**: When the MMU is operating in this mode; Dual Indication monitoring detects simultaneously active inputs of Green and Yellow, Green and Red, Yellow and Red, Walk and Yellow, or Walk and Red on the same channel. When any two inputs of a channel are sensed as active for more than 1000 milliseconds, the MMU transfers the Output relay contacts to the fault condition and illuminates the DUAL IND indicator.

**Type 16**: When the MMU is operating in this mode; Dual Indication monitoring detects simultaneously active inputs of Green and Yellow, Green and Red, or Yellow and Red on the same channel. When any two inputs of a channel are sensed as active for more than 1000 milliseconds, the MMU transfers the Output relay contacts to the fault condition, illuminates the DUAL IND indicator, and sets the Spare Bit #2 bit (bit 68) of the Type 129 Frame to 1.

Dual Indication monitoring is disabled when the Red Enable input is not active or if the Load Switch Flash bit (bit 112) of the Type 0 Frame is set to 1.

The MMU remains in this fault condition until the unit is reset by the activation of the front panel reset switch or the activation of the Reset input. An MMU Power Failure does not reset the MMU when it has been triggered by detection of Dual Indications on a channel prior to the MMU Power Failure.

### 1.2.7 GY-DUAL INDICATION MONITORING

This monitoring function detects simultaneously active inputs of Green and Yellow field signal inputs on the same channel. When the Green and Yellow inputs of a channel are sensed as active for more than 1000 milliseconds the MMU transfers the Output relay contacts to the fault condition, illuminates the DUAL IND indicator, and sets the Spare Bit #2 bit (bit 68) of the Type 129 Frame to 1.

The MMU remains in this fault condition until the unit is reset by the activation of the front panel reset switch or the activation of the Reset input. An MMU Power Failure does not reset the MMU when it has been triggered by detection of GY-Dual Indications on a channel prior to the MMU Power Failure. GY-Dual Indication Monitoring may be enabled concurrently with Dual Indication Monitoring.

GY-Dual Indication Monitoring is enabled by the use of the front panel option switch labeled GY ENABLE. When the GY-Dual Indication Monitoring option is enabled, all channels which have the front panel FIELD CHECK/DUAL ENABLE switches set to OFF will be individually monitored for simultaneously active Green and Yellow inputs. All channels that have the front panel FIELD CHECK/DUAL ENABLE switches set to ON will function as described above in Dual Indication Monitoring (Section 1.2.6).

GY-Dual Indication monitoring is disabled when the Red Enable input is not active or if the Load Switch Flash bit (bit 112) of the Type 0 Frame is set to 1.

### 1.2.8 FIELD CHECK MONITORING

This monitoring function combines information about active field inputs with information received through the Port 1 communications between the Controller Unit and the MMU in a TS 2 Cabinet Assembly. The MMU will receive a Type 0 Frame from the Controller Unit (Type 1 or Type 2 CU) that contains an image of the controller output commands to the load switches.

When the field signal input states detected as active or inactive by the MMU do not correspond with the information received from the Controller Unit in the Type 0 Frame for 10 consecutive 100 millisecond periods, the MMU will enter the fault mode, transfer the Output relay contacts to the Fault position, illuminate the FIELD CHK indicator, and set the Spare Bit #1 bit (bit 67) of the Type 129 Frame to 1.

The MMU remains in this fault condition until the unit is reset by the activation of the front panel reset switch or the activation of the Reset input. An MMU Power Failure does not reset the MMU when it has been triggered by detection of Field Check fault prior to the MMU Power Failure. Field Check Monitoring is enabled concurrently with Dual Indication Monitoring.

Field Check Monitoring is enabled for each channel, individually, through the use of front panel switches labeled FIELD CHECK / DUAL ENABLES. Field Check Monitoring is disabled when the RED ENABLE input is not active.

### 1.2.9 EXTERNAL WATCHDOG MONITORING

This monitoring function detects an optional external watchdog output from a Controller Unit or other external cabinet device. The external source should toggle the EXTERNAL WATCHDOG input logic state at least once every 1000 milliseconds. If the MMU does not receive a change in state on the EXTERNAL WATCHDOG input for 1500 milliseconds, the MMU will transfer the Output relay contacts to the Fault position, flash the CVM/WD LED on the front panel, and latch the state of all inputs. When operating in the Type 16 mode, Bit 70 (Spare Bit #4) of Frame 129 shall be set to indicate an External Watchdog fault has been detected.

The MMU remains in this fault condition until the unit is reset by the activation of the front panel reset switch or the activation of the Reset input. An MMU Power Failure will not reset the MMU when it has been triggered by the detection of an External Watchdog fault prior to the MMU Power Failure.

This monitoring function is enabled by use of the front panel option switch labeled WD ENABLE. The EXTERNAL WATCHDOG input is connected to pin "S" on Connector B (Spare 2).

### 1.2.10 PROGRAM CARD ABSENT MONITORING

If the Program Card is not present or not seated properly in the connectors, the MMU unit will enter the fault mode, transfer the Output relay contacts to the Fault position, and illuminate the PRGM CARD indicator on the front panel. The MMU remains in this fault condition until the program card is properly inserted and the unit is reset by the activation of the front panel reset switch or the activation of the Reset input. An MMU Power Failure will reset the MMU when it has been triggered by the detection of a Program Card fault prior to the MMU Power Failure.

### 1.2.11 DISPLAY LED TEST

All of the LEDs on the front panel can be illuminated by pressing the front panel reset switch or activating the Reset input. When the reset switch is pressed or the

Reset input activated, all of the LEDs will illuminate for 300 milliseconds. This allows the user to insure that all displays are functioning correctly.

A more comprehensive test of the front panel LEDs is available through the software. This testing allows for row and column testing of the display to insure correct control of each LED.

### 1.2.12 12 VOLT DC MONITORING

This feature converts the +24V Monitor II (Connector B - pin "R") to a +12V Monitor. This feature can be very useful in TS 2 cabinets with 12 VDC supplies. The MMU can now monitor a +12VDC supply as well as a +24 VDC supply. The operation of the input is the same as if it were the +24V Monitor II; only the voltage levels are changed.

A voltage greater than +11.5 volts DC applied to the +24 Volt Monitor II input is recognized by the MMU as adequate for proper operation of the CA. A voltage of less than +10.75 volts DC applied to the +24 Volt Monitor II input is recognized by the MMU as inadequate for proper operation of the CA.

When the +24 Volt Monitor II input is detected as inadequate for more than 175 milliseconds, the MMU transfers the Output relay contacts to the fault condition and sets the +24 Volt Monitor II bit (bit 59) of the Type 129 Frame to 1. The time interval between the beginning of the inadequate voltage level and the transfer of the Output relay contacts to the fault condition does not exceed 450 milliseconds.

Restoration of proper voltage level resets the +24V Monitor II portion of the MMU. A failure during the programmed Minimum Flash time or during an MMU Power Failure does not cause a fault condition.

A method of programming is provided on the programming card to cause the +24 volt DC failures to latch in the fault condition until the unit is reset by the activation of the front panel reset switch or activation of the Reset input. This also applies when the +24V Monitor II input has been converted to a +12V Monitor. A latched +12 volt DC failure is not reset by an MMU Power Failure.

Application of a True (Low) state to the +24V Monitor Inhibit input inhibits the operation of the +12 Volt Monitor.

This monitoring function is enabled by a front panel option switch labeled CONVERT 24V-2 TO 12VDC.

### 1.2.13 DISABLE LOCAL FLASH

This feature is used to ignore the status of the Local Flash input (Connector B - pin "c"). This feature is useful when you want to ignore a command to flash operation of the intersection. This may come from a Time Clock or an output of the Controller that is controlled by Time Of Day, Coordination, or a System Master.

### 1.2.14 MODIFIED CVM LATCH

This feature is useful in cabinets where the CVM input may not always be valid within the programmed Minimum Flash time and where latched CVM failures is desired. In the modified mode of operation, the MMU will not latch a CVM failure until the CVM input has been valid for more than 175 milliseconds.

This function is enabled by a front panel option switch labeled MODIFIED CVM LATCH. This feature only has an effect if the CVM Latch jumper is installed on the programming card.

### 1.2.15 TYPE 16 ONLY MODE

This feature if useful in cabinets where the user is retrofitting a TS 2 monitor into a TS 1 cabinet and wants to use the Type 16 mode, but the existing Connector A harness does not have a wire for pin "HH" (Type Select). Activating this feature forces the MMU to operate in the Type 16 mode regardless of the logic level on the Type Select input. While this feature is on, the TYPE 12 LED will show the Function Disabled indication (50 milliseconds on, once every two seconds).

This function is enabled by a front panel option switch labeled TYPE 16 ONLY.

### 1.2.16 FLASHING DON'T WALK MONITORING

This feature if useful when the user wants to insure that flashing Don't Walk displays do not conflict with other greens, yellows, or walks at the intersection. In order to use this feature the software must be used to set the channels that this feature is enabled for. The factory default for this feature is no channels enabled.

Flashing Don't Walk Monitoring watches the channel RED input for a flashing condition. A flashing condition is defined as remaining in a state for at least 200 milliseconds but no longer than 600 milliseconds. If the input stays in a state longer than 600 milliseconds, it is no longer considered as flashing. When Flashing Don't Walk Monitoring is enabled for a channel, a flashing RED input is checked for conflicts the same as the GREEN, WALK, and YELLOW inputs for that channel. The difference being that a Flashing Don't Walk conflict must exist for 1500 milliseconds to be detected as a fault. This time allows the MMU sufficient time to detect transitions from the flashing state to the solid on state and not falsely trip.

When a fault is detected due to this feature, it is displayed as a CONFLICT and the channel with a flashing RED input that was involved in the detected fault will be flashing its RED LED. Without this feature enabled, a RED input cannot be part of a conflict fault.

This function is enabled by a front panel option switch labeled FLASH DW ENABLE.

To view the channels that will have flashing Don't Walk monitoring enabled by the front panel option switch, perform the following steps:

1. Press and hold the front panel RESET switch.
2. Move the front panel option switch labeled FLASH DW ENABLE to the OFF position if not already there.
3. Move the front panel option switch labeled FLASH DW ENABLE to the ON.
4. The Red channel LEDs will now display an ON for channels with this feature enabled.
5. Release the front panel RESET switch and the MMU display will return to normal operation.
6. Set the front panel option switch labeled FLASH DW ENABLE to the desired position.

**NOTE**: The MMU will continue to operate normally while in this display mode. Any fault detected while in this mode will be displayed correctly when the front panel RESET switch is released.

### 1.2.17 CO-CHANNEL MONITORING

This feature is useful when the user has a channel that may have all outputs off while another channel's output is on for the movement of traffic. Overlaps and Protected/Permitted applications are common uses. Under normal operation, the

Red Enable input would have to be inactivated during the time that channel would have no output, to keep a Red Fail fault from occurring. The Co-Channel monitoring feature allows the user to select other channels that will be tested along with the parent channel such that a Red Fail fault will only occur if the parent channel has no outputs on and the Green, Walk, and optionally the Yellow of the child channels have no output on.

Co-Channel Monitoring is configured for each channel, individually, through the use of the software. When a channel is programmed as a child of another channel, it is a one way relationship. Therefore, if channel 9 is assigned as a child of channel 2 there is no implied reverse relationship of channel 2 being a child of channel 9. If this operation is desired, it must be explicitly programmed as such.

Co-Channel Monitoring is enabled on the front panel via the option switch labeled PER CHAN RED ENABLE. Per Channel Red Enable and Co-Channel Monitoring are both activated at the same time by the same option switch. Co-Channel Monitoring is disabled when the RED ENABLE input is not active.

#### 1.2.17.1 Co-Channel Childs Include Yellow

Setting the "Co-Chan Childs Incl Yel" user option in RaeComM will cause the Yellow display to be included from the child channels when testing for Red Fail faults. If "Co-Chan Childs Incl Yel" is not selected, then only the Green and Walk (if in Type 12 mode) will be used from the child channels.

### 1.2.18 PER CHANNEL RED ENABLE

This feature is useful when the user wants to monitor a display that may not be directly controlled by the controller but still wants to have Dual Indication testing for the channel. A typical application is an advance warning sign. The user may want to insure that both indications are not on at the same time and that neither is on during specific times. The Per Channel Red Enable feature gives the user the ability to permanently disable the Red Enable function and Field Check for specific channels. The Dual Indication function will still operate according to the FIELD CHECK/DUAL IND option switches on the front of the MMU. For the purpose of the Conflict function and the Short Clearance functions, a dark channel is treated as if it were RED.

Per Channel Red Enable is enabled for each channel, individually, through the use of the software. Per Channel Red Enable is enabled on the front panel via the option switch labeled PER CHAN RED ENABLE. Per Channel Red Enable and Co-Channel Monitoring are both activated at the same time by the same option switch. Per Channel Red Enable is disabled when the RED ENABLE input is not active.

### 1.2.19 TEMPERATURE SENSOR

The MMU-1600 has provision for monitoring the temperature inside of the cabinet. The temperature sensor is capable of monitoring temperatures in the range of -40°F to +214°F (-40°C to +101°C). The internal cabinet temperature is included in the data logged into Prior Faults Log when an appropriate fault occurs. If the actual temperature inside the cabinet is below -40°F (-40°C) at the time the fault occurs, the temperature is logged as -40°F (-40°C). If the actual temperature inside the cabinet is above +214°F (+101°C) at the time the fault occurs, the temperature is logged as +214°F (+101°C).

## 1.3 EVENT LOGGING

Six different Event Logs provide detailed, date and time stamped documentation of selected events recorded by the MMU. This data is useful in troubleshooting and provides an accurate historical record of cabinet operation. When the date and time are not available through Port 1, the MMU will use its internal Real Time Clock as a date/time stamp for events.

### 1.3.1 TIME CHANGE LOG

The Time Change Log records the 50 most recent time changes. Data recorded: Original Date/Time Stamp, New Date/Time Stamp, and Uptime Accumulator.

### 1.3.2 MMU RESET LOG

The MMU Reset Log records the 20 most recent resets. Data recorded: Date/Time Stamp, Faults at Time of Reset, and Source of Reset (Front Panel, External, or Power Loss).

### 1.3.3 CONFIGURATION EVENT LOG

The Configuration Event Log records the 10 most recent configuration changes. Data recorded: Date/Time Stamp, Program Card Jumpers, Front Panel DIP Switch Settings, Type Select, Factory Options set through the software, and User Options set through the software.

### 1.3.4 PRIOR FAULTS LOG

The Prior Faults Log records the 20 most recent faults. Data recorded: Date/Time Stamp; Cabinet Temperature; Faults Reported; Status of all Greens, Yellows, Reds, and Walks; Status of all DC Inputs; Status of Red Enable; Entire Front Panel Fault Display; AC Line Voltage; and Red Enable Voltage.

### 1.3.5 AC LINE LOG

The AC Line Log records the 50 most recent changes in AC line status. Data recorded: Date/Time Stamp, Event Type (Power Up/Reset, Low Voltage, Low Voltage Recovery, Shutdown, Low Voltage Alarm, Low Voltage Alarm Recovery, High Voltage Alarm, and High Voltage Alarm Recovery), and AC Line Voltage.

Through the software, the user can adjust the High Voltage Alarm point and the Low Voltage Alarm point. These alarm points have a fixed, three volt hysteresis. Therefore, setting the High Voltage Alarm point to 135 volts will cause the recovery point to be set to 132 volts. Likewise, setting the Low Voltage Alarm point to 105 volts will cause the recovery point to be 108 volts. The factory defaults for these alarm points are 105 volts for the low alarm point and 135 volts for the high alarm point.

NOTE: The log will only record when these points are crossed. The minimum and maximum voltages seen are not recorded.

### 1.3.6 SIGNAL SEQUENCE LOG

The Signal Sequence Log can be configured to record events occurring prior to a fault in one of two different modes.

**Event Mod :** The Signal Sequence Log records the 60 most recent events preceding the failure. An event is defined as an instance when any AC or DC signal changes state. The MMU checks all inputs for changes in state every 33 milliseconds for the purpose of accumulating data for this log. Data recorded: Time Prior to Fault; Status of all Greens, Yellows, Reds, and Walks; RMS Voltages of all

Greens, Yellows, Reds, and Walks; Status of all DC inputs; Status of Red Enable; AC Line Voltage; Red Enable Voltage; and DC Input Voltages.

**Tim Mod :** The Signal Sequence Log records the 2 seconds preceding the failure. The MMU records all inputs every 33 milliseconds for the purpose of accumulating data for this log. Data recorded: Time Prior to Fault; Status of all Greens, Yellows, Reds, and Walks; RMS Voltages of all Greens, Yellows, Reds, and Walks; Status of all DC inputs; Status of Red Enable; AC Line Voltage; Red Enable Voltage; and DC Input Voltages.

## 2.0 SPECIFICATIONS

### 2.1 PHYSICAL

WEIGHT: 75.2 oz. (2132 gm).

SIZE: 10.50 inches (26.67 cm) high x 4.50 inches (12.60 cm) wide x 11.00 inches (27.94 cm) deep including connectors, card ejectors, and harness.

STORAGE TEMPERATURE: -50°F to +185°F (-45°C to +85°C).

OPERATING TEMPERATURE: -30°F to +165°F (-34°C to +74°C).

HUMIDITY RANGE: 0 to 95% (relative).

CIRCUIT BOARDS: Printed circuit boards are 0.062 inch thick NEMA FR-4 glass epoxy with 2 oz. copper on both sides and plated through holes. Circuit boards and components are conformal coated with polyurethane.

CONNECTORS: (See Section 3.4 for connector pin assignments.)

CONNECTOR A: Intermates with a MS 3116 22-55 SZ.

CONNECTOR B: Intermates with a MS 3112 16-26 S.

PORT 1 SDLC CONNECTOR: 15 pin, metal shell, D subminiature receptacle with gold plated female contacts and latching blocks.

COMM PORT CONNECTOR: 9 pin, metal shell, D subminiature receptacle with gold plated female contacts and nuts for retaining screws.

## 2.2 ELECTRICAL

POWER: 80 to 135 VAC, 60 Hz ±3Hz, 6 watts (nominal).

AC VOLTAGE INPUTS:

| | | |
|---|---|---|
| Green Signal Inputs: | OFF ..... < 15Vrms | ON ..... > 25Vrms |
| Walk Signal Inputs: | OFF ..... < 15Vrms | ON ..... > 25Vrms |
| Yellow Signal Inputs: | OFF ..... < 15Vrms | ON ..... > 25Vrms |
| Red Signal Inputs: | OFF ..... < 50Vrms | ON ..... > 70Vrms |
| Red Enable Input: | OFF ..... < 70Vrms | ON ..... > 89Vrms |

POWER FAIL:

| | | |
|---|---|---|
| AC Line Input: | Dropout. < 89Vrms | Restore . > 98Vrms |

DC VOLTAGE INPUTS:

| | | |
|---|---|---|
| +24VDC Inputs: | Fault..... < +18VDC | No Fault > +22VDC |
| +12VDC Input: | Fault..... < +10.75VDC | No Fault > +11.5VDC |

LOGIC INPUTS:

| | | |
|---|---|---|
| CVM: | True ..... < +8VDC | False..... > +16VDC |
| External Reset Input: | True ..... < +8VDC | False..... > +16VDC |
| +24V Monitor Inhibit Input: | True ..... < +8VDC | False..... > +16VDC |
| Port1 Disable Input: | True ..... < +8VDC | False..... > +16VDC |
| Type Select Input: | True ..... < +8VDC | False..... > +16VDC |
| Local Flash Input: | True ..... < +8VDC | False..... > +16VDC |
| External Watchdog Input: | True ..... < +8VDC | False..... > +16VDC |

RESET: Meets and/or exceeds NEMA TS 2-1998 specifications. The MMU can be manually reset by depressing the RESET button on the front panel.

## 2.3 TIMING FUNCTIONS

| | | | |
|---|---|---|---|
| START DELAY: | | | 2.0 sec (±0.5 sec) |
| MINIMUM FLASH: | | | 6 to 16 sec (±1 sec) |
| PORT 1 FAIL: | | | Typical 300 msec |
| FIELD CHECK FAIL: | | | Typical 1000 msec |
| CONFLICT: | No Fault < 200msec | Detect....> 450 msec | Typical 300 msec |
| RED FAIL: | No Fault < 700 msec | Detect....> 1000 msec | Typical 800 msec |
| CVM FAULT: | No Fault < 125 msec | Detect....> 175 msec | Typical 150 msec |
| +24VDC MONITOR: | No Fault < 125 msec | Detect....> 175 msec | Typical 150 msec |
| CLEARANCE FAIL: | No Fault < 2.8 sec | Detect....> 2.6 sec | Typical 2.7 sec |
| DUAL INDICATION: | No Fault < 300 msec | Detect....> 700 msec | Typical 500 msec |
| MMU POWER FAIL: | Ignore.... < 450 msec | Respond > 500 msec | Typical ..... 483 msec |

FLASHING DON'T WALK: Flashing if state changes are > 200 msec and < 600 msec
Typical .. 500 msec
No Fault < 1400 msec Respond >1600 msec Typical
1500 msec

## 2.4 TABLES: CONNECTOR PIN ASSIGNMENTS

### 2.4.1 CONNECTOR A

| PIN | FUNCTION (TYPE 16) | I/O | FUNCTION (TYPE 12) | I/O |
|---|---|---|---|---|
| A | AC Line | I | AC Line | I |
| B | Output Relay 1 N.O. (Closes When Fault | O | Output Relay 1 N.O. (Closes When Fault | O |
| C | Output Relay 2 N.C. (Opens When Fault | O | Output Relay 2 N.C. (Opens When Fault | O |
| D | Channel 12 Green | I | Channel 12 Green | I |
| E | Channel 11 Green | I | Channel 11 Green | I |
| F | Channel 10 Green | I | Channel 10 Green | I |
| G | Channel 9 Green | I | Channel 9 Green | I |
| H | Channel 8 Green | I | Channel 8 Green | I |
| J | Channel 7 Green | I | Channel 7 Green | I |
| K | Channel 6 Green | I | Channel 6 Green | I |
| L | Channel 5 Green | I | Channel 5 Green | I |
| M | Channel 4 Green | I | Channel 4 Green | I |
| N | Channel 3 Green | I | Channel 3 Green | I |
| P | Channel 2 Green | I | Channel 2 Green | I |
| R | Channel 1 Green | I | Channel 1 Green | I |
| S | +24V Monitor I | I | +24V Monitor I | I |
| T | Logic Ground | I | Logic Ground | I |
| U | Earth Ground | I | Earth Ground | I |
| V | AC Neutral | I | AC Neutral | I |
| W | Output Relay 1 Common | I | Output Relay 1 Common | I |
| X | Output Relay 2 Common | I | Output Relay 2 Common | I |
| Y | Channel 12 Yellow | I | Channel 12 Yellow | I |
| Z | Channel 11 Yellow | I | Channel 11 Yellow | I |
| a | Channel 10 Walk (Type 12 Only) | I | Channel 10 Walk | I |
| b | Channel 10 Yellow | I | Channel 10 Yellow | I |
| c | Channel 9 Yellow | I | Channel 9 Yellow | I |
| d | Channel 8 Yellow | I | Channel 8 Yellow | I |
| e | Channel 7 Yellow | I | Channel 7 Yellow | I |
| f | Channel 6 Yellow | I | Channel 6 Yellow | I |
| g | Channel 5 Yellow | I | Channel 5 Yellow | I |
| h | Channel 3 Yellow | I | Channel 3 Yellow | I |
| i | Channel 15 Green | I | Channel 3 Walk | I |
| j | Channel 2 Yellow | I | Channel 2 Yellow | I |
| k | Channel 1 Yellow | I | Channel 1 Yellow | I |
| m | Controller Voltage Monitor | I | Controller Voltage Monitor | I |
| n | +24V Monitor Inhibit | I | +24V Monitor Inhibit | I |
| p | Output Relay 1 N.C. (Opens When Fault | O | Output Relay 1 N.C. (Opens When Fault | O |
| q | Output Relay 2 N.O. (Closes When Fault | O | Output Relay 2 N.O. (Closes When Fault | O |
| r | Channel 12 Walk (Type 12 Only) | I | Channel 12 Walk | I |
| s | Channel 11 Walk (Type 12 Only) | I | Channel 11 Walk | I |
| t | Channel 9 Walk (Type 12 Only) | I | Channel 9 Walk | I |
| u | Channel 16 Yellow | I | Channel 8 Walk | I |
| v | Channel 15 Yellow | I | Channel 7 Walk | I |
| w | Channel 13 Yellow | I | Channel 5 Walk | I |
| x | Channel 4 Yellow | I | Channel 4 Yellow | I |
| y | Channel 14 Green | I | Channel 2 Walk | I |
| z | Channel 13 Green | I | Channel 1 Walk | I |
| AA | Spare 1 | - | Spare 1 | - |
| BB | Reset | I | Reset | I |
| CC | Cabinet Interlock A | I | Cabinet Interlock A | I |
| DD | Cabinet Interlock B | O | Cabinet Interlock B | O |
| EE | Channel 14 Yellow | I | Channel 6 Walk | I |
| FF | Channel 16 Green | I | Channel 4 Walk | I |
| GG | Spare 2 | - | Spare 2 | - |
| HH | Type Select | I | Type Select | I |

### 2.4.2 CONNECTOR B

| PIN | FUNCTION (TYPE 16) | I/O | FUNCTION (TYPE 12) | I/O |
|---|---|---|---|---|
| A | AC Line | I | AC Lin | I |
| B | Start-Delay Relay Common | I | Start-Delay Relay Common | I |
| C | Start-Delay Relay N.O. (Closed During | O | Start-Delay Relay N.O. (Closed During | O |
| D | Channel 12 Red | I | Channel 12 Red | I |
| E | Channel 11 Red | I | Channel 11 Red | I |
| F | Channel 9 Red | I | Channel 9 Red | I |
| G | Channel 8 Red | I | Channel 8 Red | I |
| H | Channel 7 Red | I | Channel 7 Red | I |
| J | Channel 6 Red | I | Channel 6 Red | I |
| K | Channel 5 Red | I | Channel 5 Red | I |
| L | Channel 4 Red | I | Channel 4 Red | I |
| M | Channel 2 Red | I | Channel 2 Red | I |
| N | Channel 1 Red | I | Channel 1 Red | I |
| P | Spare 1 | - | Spare 1 | - |
| R | +24V Monitor II | I | +24V Monitor II | I |
| S | External Watchdog (Spare 2) | I | External Watchdog (Spare 2) | I |
| T | Channel 13 Red | I | Channel 13 Red (Type 16 Only) | I |
| U | Start-Delay Relay N.C. (Open During | O | Start-Delay Relay N.C. (Open During | O |
| V | Channel 10 Red | I | Channel 10 Red | I |
| W | Channel 14 Red | I | Channel 14 Red (Type 16 Only) | I |
| X | Channel 15 Red | I | Channel 15 Red (Type 16 Only) | I |
| Y | Channel 16 Red | I | Channel 16 Red (Type 16 Only) | I |
| Z | Channel 3 Red | I | Channel 3 Red | I |
| a | Red Enable | I | Red Enable | I |
| b | Spare 3 | - | Spare 3 | - |
| c | Local Flash Status | I | Local Flash Status | I |

### 2.4.3 PORT 1 SDLC & COMM PORT CONNECTORS

| PORT 1 SDLC CONNECTOR | |
|---|---|
| PIN | FUNCTION |
| 1 | RX Data + |
| 2 | Logic Ground |
| 3 | RX Clock + |
| 4 | Logic Ground |
| 5 | TX Data + |
| 6 | Logic Ground |
| 7 | TX Clock + |
| 8 | Logic Ground |
| 9 | RX Data - |
| 10 | Port 1 Disable (0VDC = |
| 11 | RX Clock - |
| 12 | Earth Ground |
| 13 | TX Data - |
| 14 | Reserved |
| 15 | TX Clock - |

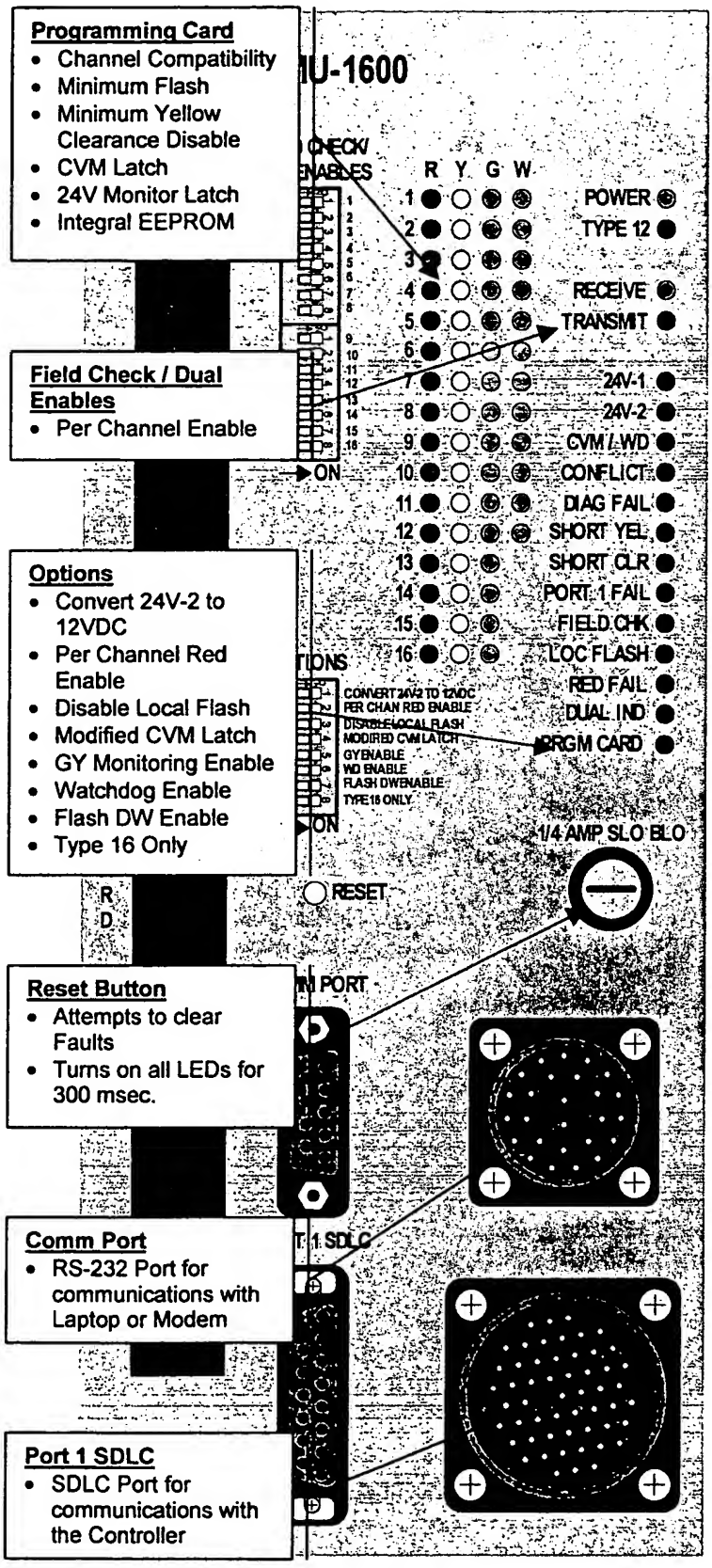
| COMM PORT CONNECTOR | |
|---|---|
| PIN | FUNCTION |
| 1 | No Connection |
| 2 | TX Data |
| 3 | RX Data |
| 4 | No Connection |
| 5 | Ground |
| 6 | No Connection |
| 7 | No Connection |
| 8 | No Connection |
| 9 | No Connection |

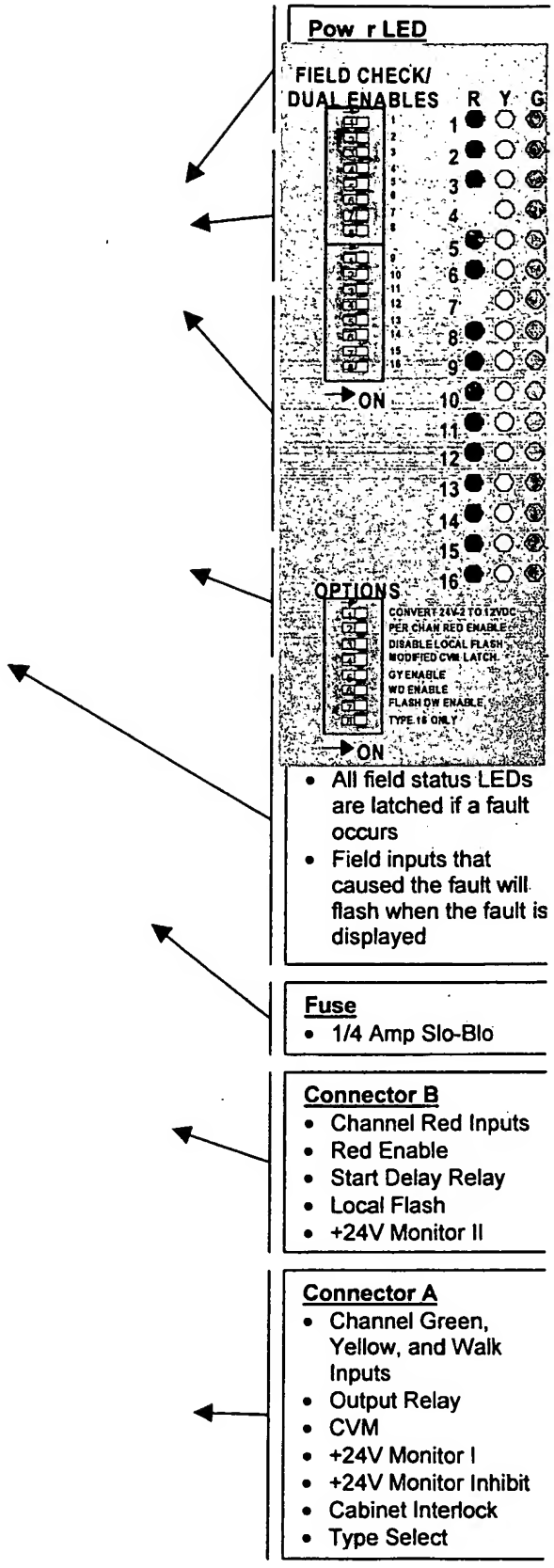
## 2.5 TABLE: PROGRAMMING CARD PIN ASSIGNMENTS

| | CONNECTOR P1 | | | | CONNECTOR P2 | | |
|---|---|---|---|---|---|---|---|
| PIN | ROW A CHANNEL PAIR | ROW B CHANNEL PAIR | ROW C CHANNEL PAIR | PIN | ROW A CHANNEL PAIR | ROW B CHANNEL PAIR | ROW C CHANNEL PAIR |
| 1 | 1-2 | 1-3 | 1-4 | 1 | 9-11 | 9-12 | 9-13 |
| 2 | 1-5 | 1-6 | 1-7 | 2 | 9-14 | 9-15 | 9-16 |
| 3 | 1-8 | 1-9 | 1-10 | 3 | 10-11 | 10-12 | 10-13 |
| 4 | 1-11 | 1-12 | 1-13 | 4 | 10-14 | 10-15 | 10-16 |
| 5 | 1-14 | 1-15 | 1-16 | 5 | 11-12 | 11-13 | 11-14 |
| 6 | 2-3 | 2-4 | 2-5 | 6 | 11-15 | 11-16 | 12-13 |
| 7 | 2-6 | 2-7 | 2-8 | 7 | 12-14 | 12-15 | 12-16 |
| 8 | 2-9 | 2-10 | 2-11 | 8 | 13-14 | 13-15 | 13-16 |
| 9 | 2-12 | 2-13 | 2-14 | 9 | 14-15 | 14-16 | 15-16 |
| 10 | 2-15 | 2-16 | 3-4 | 10 | MYCD-1 | MYCD-2 | MYCD-3 |
| 11 | 3-5 | 3-6 | 3-7 | 11 | MYCD-4 | MYCD-5 | MYCD-6 |
| 12 | 3-8 | 3-9 | 3-10 | 12 | MYCD-7 | MYCD-8 | MYCD-9 |
| 13 | 3-11 | 3-12 | 3-13 | 13 | MYCD-10 | MYCD-11 | MYCD-12 |
| 14 | 3-14 | 3-15 | 3-16 | 14 | MYCD-13 | MYCD-14 | MYCD-15 |
| 15 | 4-5 | 4-6 | 4-7 | 15 | MYCD-16 | Reserved | Reserved |
| 16 | 4-8 | 4-9 | 4-10 | 16 | Reserved | Reserved | Reserved |
| 17 | 4-11 | 4-12 | 4-13 | 17 | Reserved | Reserved | Reserved |
| 18 | 4-14 | 4-15 | 4-16 | 18 | Reserved | Reserved | Reserved |
| 19 | 5-6 | 5-7 | 5-8 | 19 | Reserved | Reserved | Reserved |
| 20 | 5-9 | 5-10 | 5-11 | 20 | Reserved | Reserved | Reserved |
| 21 | 5-12 | 5-13 | 5-14 | 21 | Minimum | Minimum | Minimum |
| 22 | 5-15 | 5-16 | 6-7 | 22 | Minimum | 24V Latch | CVM Latch |
| 23 | 6-8 | 6-9 | 6-10 | 23 | Reserved | Reserved | Reserved |
| 24 | 6-11 | 6-12 | 6-13 | 24 | Reserved | Reserved | Reserved |
| 25 | 6-14 | 6-15 | 6-16 | 25 | Reserved | Reserved | Reserved |
| 26 | 7-8 | 7-9 | 7-10 | 26 | Reserved | Reserved | Reserved |
| 27 | 7-11 | 7-12 | 7-13 | 27 | Reserved | Reserved | Reserved |
| 28 | 7-14 | 7-15 | 7-16 | 28 | Reserved | Reserved | Reserved |
| 29 | 8-9 | 8-10 | 8-11 | 29 | Reserved | Reserved | Reserved |
| 30 | 8-12 | 8-13 | 8-14 | 30 | +5VDC | Reserved | EEPROM |
| 31 | 8-15 | 8-16 | 9-10 | 31 | EEPROM | Reserved | EEPROM |
| 32 | Common | Common | Common | 32 | Common | Common | Common |

## 2.6 TABLE: PROGRAMMING CARD MINIMUM FLASH PROGRAMMING

| POSITION 8 | POSITION 4 | POSITION 2 | POSITION 1 | DELAY TIME (SECONDS) |
|---|---|---|---|---|
| Open | Open | Open | Open | 6 |
| Open | Open | Open | Jumper | 6 |
| Open | Open | Jumper | Open | 6 |
| Open | Open | Jumper | Jumper | 6 |
| Open | Jumper | Open | Open | 6 |
| Open | Jumper | Open | Jumper | 6 |
| Open | Jumper | Jumper | Open | 7 |
| Open | Jumper | Jumper | Jumper | 8 |
| Jumper | Open | Open | Open | 9 |
| Jumper | Open | Open | Jumper | 10 |
| Jumper | Open | Jumper | Open | 11 |
| Jumper | Open | Jumper | Jumper | 12 |
| Jumper | Jumper | Open | Op n | 13 |
| Jumper | Jumper | Open | Jumper | 14 |
| Jumper | Jumper | Jumper | Open | 15 |
| Jumper | Jumper | Jump r | Jumper | 16 |


Programming Card
• Channel Compatibility
• Minimum Flash
• Minimum Yellow Clearance Disable
• CVM Latch
• 24V Monitor Latch
• Integral EEPROM
Field Check / Dual Enables
• Per Channel Enable
Options
• Convert 24V-2 to 12VDC
• Per Channel Red Enable
• Disable Local Flash
• Modified CVM Latch
• GY Monitoring Enable
• Watchdog Enable
• Flash DW Enable
• Type 16 Only
Reset Button
• Attempts to clear Faults
• Turns on all LEDs for 300 msec.
Comm Port
• RS-232 Port for communications with Laptop or Modem
Port 1 SDLC
• SDLC Port for communications with the Controller
R Y G W
POWER
TYPE 12
RECEIVE
TRANSMIT
24V-1
24V-2
CVM / WD
CONFLICT
DIAG FAIL
SHORT YEL
SHORT CLR
PORT 1 FAIL
FIELD CHK
LOC FLASH
RED FAIL
DUAL IND
BRGM CARD
1/4 AMP SLO BLO
RESET
ON


Pow r LED
FIELD CHECK/
DUAL ENABLES
R Y G
ON
OPTIONS
ON
• All field status LEDs are latched if a fault occurs
• Field inputs that caused the fault will flash when the fault is displayed
Fuse
• 1/4 Amp Slo-Blo
Connector B
• Channel Red Inputs
• Red Enable
• Start Delay Relay
• Local Flash
• +24V Monitor II
Connector A
• Channel Green, Yellow, and Walk Inputs
• Output Relay
• CVM
• +24V Monitor I
• +24V Monitor Inhibit
• Cabinet Interlock
• Type Select

## FRONT PANEL DIP SWITCHES

### 3.1.1 FIELD CHECK / DUAL INDICATION ENABLES

There are 16 DIP switches on the front panel that enable, on a per channel basis, Field Check monitoring and Dual Indication monitoring. When a switch is OFF, neither Field Check monitoring or Dual Indication monitoring will occur for that channel.

### 3.1.2 CONVERT 24V-2 TO 12VDC

When ON, the +24V Monitor II input thresholds will be modified to monitor 12VDC. The new voltage threshold will be 11.5VDC and above, sensed as valid; 10.75VDC and below, sensed as invalid. Voltages between these thresholds may be sensed as valid or invalid. See Section 2.2.12 for more information.

### 3.1.3 PER CHANNEL RED ENABLE (& CO-CHANNEL ENABLE)

When ON, the MMU will only perform Red Fail and Field Check monitoring for channels that have been enabled for this feature when the Red Enable input is active. The factory defaults for the channel settings for this option is all channels enabled. These channel settings can only be modified through the use of the RaeComM software.

Only the Red Fail and Field Check monitoring are affected by this feature. Other monitoring normally controlled by the Red Enable input (Short Yellow, Short Clearance, and Dual Indication) still operate as defined and are not affected in any way by the activation of this feature.

This option switch also activates the Co-Channel feature. The Co-Channel feature allows the user to modify the Red Fail test for each channel to include the Green, Yellow, and Walk displays from other channels. The factory defaults for the channel settings for this option is all channels have no childs enabled. These channel settings can only be modified through the use of the RaeComM software.

To view the channels that will have Red Fail and Field Check monitoring enabled when this feature is activated, perform the following steps:

1. Press and hold the front panel RESET switch.
2. The MMU will still continue to perform all monitoring tests while the RESET switch is pressed.
3. Move the option switch labeled PER CHAN RED ENABLE to the OFF position, if not already there.
4. Move the option switch labeled PER CHAN RED ENABLE to the ON position.
5. Red channel LEDs will display an ON for channels with this feature enabled.
6. Release the front panel RESET switch to return to normal operation.
7. Set the option switch labeled PER CHAN RED ENABLE to the desired position.

**NOTE**: The MMU will continue to operate normally while in this display mode. Any fault detected while in this mode will be displayed correctly when the front panel RESET switch is released.

### 3.1.4 DISABLE LOCAL FLASH

When ON, the MMU will ignore the LOCAL FLASH input. The LOC FLASH indicator will show this function as disabled (50 milliseconds on, once every two seconds) when this feature is active.

### 3.1.5 MODIFIED CVM LATCH

When ON and the CVM Latch Enable jumper is installed on the Programming Card, the CVM input will not latch a CVM failure until the CVM input has been valid for more than 175 milliseconds. This feature basically requires that CVM be valid before a CVM fault will be latched. This feature is used when there may be times that the controller will not place CVM in the valid state before the minimum flash time has timed out and the CVM Latch Enable jumper is installed on the program card.

### 3.1.6 GY ENABLE

When ON, the MMU will monitor for simultaneously active Green and Yellow field signal inputs on the same channel. This feature is active on all channels when selected and is not active if the RED ENABLE input is not active.

The GY Enable can be used in conjunction with the FIELD CHECK / DUAL ENABLES switches on the front panel. Channels which have their FIELD CHECK / DUAL ENABLES switches ON will perform Dual Indication monitoring as described in Field Check / Dual Indication (Section 1.2.6). Channels, which have their switches OFF, will perform the GY Dual Indication monitoring (Section 1.2.7).

### 3.1.7 WD ENABLE

When ON, the MMU will monitor an optional external watchdog output from a Controller Unit or other external cabinet device. The external source should toggle the EXTERNAL WATCHDOG input logic state at least once every 1000 milliseconds. See Section 2.2.9 for more information.

The EXTERNAL WATCHDOG input is connected to pin "S" (Spare 2) on connector B.

### 3.1.8 FLASH DW ENABLE

When ON, the MMU will monitor flashing Don't Walk displays to not conflict with other greens, yellows, or walks at the intersection. In order to use this feature the RaeComM software must be used to set the channels that this feature is enabled for. The factory default for this feature is no channels enabled.

When a fault is detected due to this feature, it is displayed as a CONFLICT and the channel with a flashing RED input that was involved in the detected fault will be flashing its RED LED.

To view the channels that will have flashing Don't Walk monitoring enabled by the front panel option switch, perform the following steps:

1. Press and hold the front panel RESET switch.
2. The MMU will still continue to perform all monitoring tests while the RESET switch is pressed.
3. Move the option switch labeled FLASH DW ENABLE to the OFF position, if not already there.
4. Move the option switch labeled FLASH DW ENABLE to the ON position.
5. Red channel LEDs will display an ON for channels with this feature enabled.

6. Release the front panel RESET switch to return to normal operation.
7. Set the option switch labeled FLASH DW ENABLE to the desired position.

**NOTE**: The MMU will continue to operate normally while in this display mode. Any fault detected while in this mode will be displayed correctly when the front panel RESET switch is released.

### 3.1.9 TYPE 16 ONLY

When ON, the MMU will ignore the TYPE SELECT input pin ("HH") and force the MMU to always operate in the Type 16 mode. This feature if useful in cabinets where the user is retrofitting a TS 2 monitor into a TS 1 cabinet and wants to use the Type 16 mode, but the existing Connector A harness for the MMU does not have a wire for pin "HH" (Type Select). While this feature is on, the TYPE 12 LED will show the Function Disabled indication (50 milliseconds on, once every two seconds).

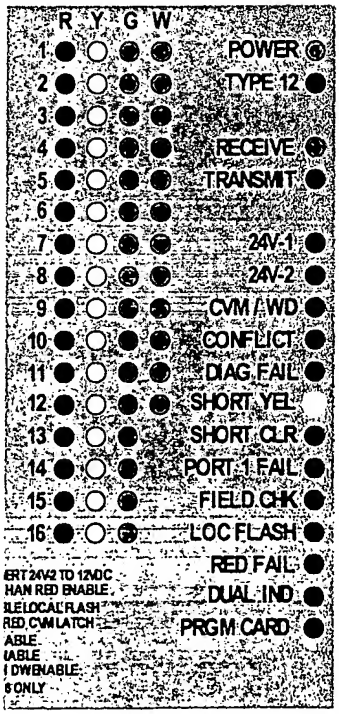
## 3.2 FRONT PANEL INDICATORS

The MMU has 77 light emitting diodes (LEDs) that are used to convey information to the user. These LEDs are color coded to increase viewability and intuitiveness of the display. The LEDs used are ultra-bright to allow viewing of the front panel indicators in direct sunlight. The front panel display is updated every 16 milliseconds by the MMU.

The front panel display is broken up into four logical groups: Field Status, Power/Type, Transmit/Receive, and Fault indicators.

### 3.2.1 FIELD STATUS INDICATORS

There are 60 field status indicators, one for each field input defined by the TS 2 specification for Type 16 and Type 12. The display is logically organized into four columns and sixteen rows. The columns are labeled R for Red, Y for Yellow, G for Green, and W for Walk indicators. The rows are numbered from 1 to 16, corresponding to the channel numbers for Type 16 and Type 12.




The indicator for a field input will be on if the RMS voltage over the last 33 milliseconds (two cycles of AC power) is above the threshold for that type of input. See Section 3.2 for the voltage levels for each type of input.

When a fault is detected, the field status is latched and the field input involved in the detected fault will flash at a 5 Hz rate. The following table lists the information displayed on the Field Status indicators during the various fault conditions.

| FAULT CONDITION | FIELD STATUS INDICATIONS |
|---|---|
| 24V-1<br>24V-2<br>CVM / WD<br>PORT 1 FAIL | ON – Field inputs that were ON for at least 33 milliseconds at the time of the fault. |
| CONFLICT | ON – Field inputs that were ON for at least 33 milliseconds at the time c the fault.<br>FLASHING – Field inputs that were ON and were the cause of the fault. |
| DIAG FAIL | ON – Field inputs that were ON for at least 33 milliseconds at the time c the fault.<br>**NOTE: This may be incorrectly displayed depending on th typ o diagnostic failure being experienced.** |
| SHORT YEL | ON – Field inputs that were ON for at least 100 milliseconds at the time c the fault.<br>FLASHING – The Yellow field inputs on which a Short Yellow was detected |
| SHORT CLR | ON – Field inputs that were ON for at least 33 milliseconds at the time c the fault.<br>FLASHING – The Green field inputs that were not OFF for at least 2.' seconds before a conflicting channel was detected as active. |
| FIELD CHK | ON – Field inputs that were ON for at least 33 milliseconds at the time c the fault.<br>FLASHING – The field inputs that did not agree with the load switcl commands from the CU. |
| LOC FLASH PRGM CARD | Current field status. (NOT LATCHED) |
| RED FAIL | ON – Field inputs that were ON for at least 100 milliseconds at the time c the fault.<br>FLASHING – All field inputs for the channel(s) that had no display. |
| DUAL IND | ON – Field inputs that were ON for at least 100 milliseconds at the time c the fault.<br>FLASHING - Field inputs that were ON and were the cause of the fault. |

### 3.2.2 POWER / TYPE INDICATORS

The POWER indicator is on continuously when the AC line voltage is above 98 VAC RMS. When the AC line voltage is below 89VAC RMS, the indicator will flash at a 1 Hz rate to indicate low line voltage. While the AC line voltage is low, all field status indicators will be off. Any active fault indicators will stay on.

The TYPE 12 indicator is on continuously when the MMU is operating in the Type 12 mode. This occurs when the Type Select input (Connector A – Pin "HH") is not at a True (Low) logic level. This indicator will have a disabled indication if the front panel switch labeled TYPE 16 ONLY is ON.

### 3.2.3 TRANSMIT / RECEIVE INDICATORS

The RECEIVE indicator turns on for 50 milliseconds every time a valid SDLC frame addressed to the MMU is received.

The TRANSMIT indicator turns on for 50 milliseconds every time a SDLC frame is transmitted.

### 3.2.4 FAULT INDICATORS

When the MMU Output relay contacts are transferred to the fault condition and the MMU is not timing Minimum Flash, a fault indicator will be illuminated to identify the source of the fault.

There are two fault indicators with dual function capability. One is the CVM/WD indicator. If the fault is a CVM fault, the indicator will be on solid. If the fault is a WD (External Watchdog) fault, the indicator will flash at a 5 Hz rate. The other fault indicator with dual function capability is the PRGM CARD indicator. The PRGM CARD indicator will be on solid if the Programming Card is not properly seated while power is applied. The PRGM CARD indicator will flash at a 5 Hz rate if an authorized Programming Card which has a defective serial EEPROM is inserted in the program card slot and the device (the EEPROM) is activated. The PRGM CARD indicator will also flash at a 5 Hz rate if an unauthorized Programming Card is inserted in the program card slot and the "Use Program Card EEPROM" feature is activated through the software.

Any monitoring function that is disabled for any reason will display a Function Disabled indication.

### 3.2.5 FUNCTION DISABLED INDICATION

When a function has been disabled, the associated indicator will turn on for 50 milliseconds once every two seconds.

Functions may be disabled for one of several different reasons:

| INDICATOR | DISABLE CONDITIONS |
|---|---|
| TYPE 12 | The front panel switch labeled TYPE 16 ONLY is ON. |
| 24V-1 | The +24V Monitor Inhibit input (Connector A – Pin "n") is at a logic TRUE (Low) state. |
| 24V-2 | The +24V Monitor Inhibit input (Connector A – Pin "n") is at a logic TRUE (Low) state. |
| SHORT YEL | The Red Enable input (Connector B – Pin "a") is below 70VAC. |
| SHORT CLR | The Red Enable input (Connector B – Pin "a") is below 70VAC. |
| PORT 1 FAIL | The Port 1 Disable input (Port 1 Connector – Pin 10) is at 0 VDC.<br>Port 1 communications are not active during Type 12 operation. |
| FIELD CHK | The Port 1 Disable input (Port 1 Connector – Pin 10) is at 0 VDC.<br>The Red Enable input (Connector B – Pin "a") is below 70VAC.<br>Port 1 communications are not active during Type 12 operation. |
| LOC FLASH | The front panel switch labeled LOCAL FLASH DISABLE is ON. |
| RED FAIL | The Red Enable input (Connector B – Pin "a") is below 70VAC.<br>The LOAD SWITCH Flash bit is set to 1 in the Type 0 frame from the Controller Unit. |
| DUAL IND | The Red Enable input (Connector B – Pin "a") is below 70VAC. |

## 3.3 AUDIBLE BUZZER

The MMU is equipped with an audible buzzer. This buzzer is used to bring important events to the attention of the user. The buzzer can be disabled for all features except

for Critical Failure. This is done through the software under CONFIG > FACTORY & USER OPTIONS.

### 3.3.1 CRITICAL FAILURE

When the MMU main microprocessor is held in the reset state due to a critical hardware failure, the buzzer will stay on constantly. There is no way to disable this indication, as it is an indication that the MMU is not operational.

### 3.3.2 CONFIGURATION CHANGE

The MMU checks for configuration changes every second. A configuration change is defined as a change of any of the following parameters:

Programming Card jumpers.
Programming Card EEPROM stored settings.
Front Panel Option switches.
Type Select.
Factory Options set through the RaeComM software.
User Options set through the RaeComM software.

If a configuration change is identified, the MMU will start to beep at a one second rate. This is the indication that a change to the current configuration has been identified. The MMU does not implement any configuration changes until the front panel RESET switch or external RESET input is activated. At that time the buzzer will stop beeping. If the configuration parameters that were changed are restored to their original states, the buzzer will stop beeping.

NOTE: If power is removed from the MMU prior to the configuration changes being accepted by pressing the RESET switch or activating the external RESET input, the pending changes will be lost and the original settings will be used on power up.